Clam Siphon Tip Nipping by Fishes in the Estuarine Cape Fear River, North Carolina

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ABSTRACT—Over two million fishes within 57 families and 173 species were collected between 1973 and 1978 in the Cape Fear River, North Carolina. Sampling consisted of repetitive six-year, 22 station gill net (2,362 sets) and otter trawl (8,284 tows) efforts. Stomachs of 82 species contained fishes. Diets of 14 species representing nine fish families were found to include clam siphon tips, primarily *Mercenaria mercenaria*. The 14 species comprised 39.7% of the total catch (798,607), and examining 21,732 stomachs found siphon nipping had occurred 453 times by 889 individuals (4.1%). Nipping was most intense in 1976 and 1977, years when river water temperatures were historically lowest, and shoal areas were subjected to large expanses of ice flows. Sampling daily, weekly, and monthly revealed that clam populations were patchy. Most "nipping" fishes were less than 126 mm in standard length ($\bar{x}$ = 90 mm SL). Most siphon tip feeding fishes were caught in September, August, and October, and least in December. Nipping behavior was dominated by croakers, hogchokers, southern kingfish, spot, pinfish, and fringed flounders.

Siphon tips of various molluscs have been noted in stomach contents of bothid, coryphaenid, elasmobranch, gerreid, pholid, sciaenid, and tetraodontid fishes (Joseph et al. 1982; McMichael and Ross 1983; Modde and Ross 1983; Cyrus and Blaber 1983, 1984; Hughes 1985; McMichael 1986; Cyrus 1988; Compagno 1990; Coen and Heck 1991). Other animals (reviewed in Kamermans and Huiteman 1954) such as crabs (Hines et al. 1990), shrimps (Kamermans and Huiteman 1994), sea otters (Kvitek et al. 1991), walrus (Welsh and Martin-Bergmann 1990), and isopods and decapods (Bonsdorff et al. 1995) are also known siphon tip nippers.

Most siphon nipping observations have been reported following food content analyses of a variety of organisms. The importance and impact of siphon nipping was discussed by Armitage and Alevizon (1980) and Kamermans and Huiteman (1994), who commented on the poor caloric value of siphon tips. Few efforts have attempted to describe the frequency of siphon tip nipping, or its effects on mollusc growth

with time (Coen and Heck 1991, Sutherland 1982, Peterson and Quammen 1982).

I document clam siphon tip nipping by 14 species of fishes captured at 22 stations in the Cape Fear River system of North Carolina during intensive gill net and otter trawl samplings (10,646 efforts) between 1973 and 1978 and discuss the impact by size of fish, station, month, year, and species.

STUDY AREA AND METHODS

The Cape Fear River south of Wilmington, North Carolina, is an estuarine system that lies entirely within, and is the largest river drainage to the Atlantic Ocean, in North Carolina (Schwartz et al. 1982). A study area was a 7,854-ha portion of the river south of Wilmington that varied 1.6–3.6 km wide, is 17 km long, and daily is subject to ±2 m tides that are affected by prevailing southeast or southwest winds during nine months of the year. It included the main river from Buoy 42, just south of Wilmington, and near Campbell Island, southward for 17 km to the ocean, and nearby Carolina Beach Inlet, Masonboro Sound (Fig. 1). (See Schwartz et al. 1979*a*, *b*; 1982) for further habitat and ecological details and descriptions.)

Yearly 22 stations (Fig. 1) were sampled, during daylight hours of 1973 through 1978, 10,646 times (2,362 gill nets sets; 8,284 otter trawl tows). Sampling occurred twice each January, weekly sampling occurred February through May and September through November, and half of December. Single monthly samplings occurred in June, July, and August of each year. Each shoal and intake canal station was sampled for pelagic species using 8.7-cm × 91.4-m gill nets set 12 hours. Semi-balloon 7.6-m (all shoal and intake canal stations) and 12.6-m (all shoal, channel, intake canal, and ocean stations) 1.9-cm-stretched mesh otter trawls towed 0.3 hour were used to capture all other species. A total of 2,013,986 fishes, within 57 families and 173 species, were collected. Entire small catches were kept, whereas large catches were subsampled using a 8.5-L pail. The resultant mixed catches and subsamples were immediately preserved in 10% formalin and later sorted in the lab. Remaining specimens of large catches were further subsampled for total number and mass, and returned alive to each original capture site. Eighty-four species and 798,607 specimens (39.7%) of the total were measured (standard length in millimeters, SL) weighed (0.1 gm), and examined for food content (Table 1). These had been obtained following sampling all stations, except Buoy 42 (80 times) and the ocean (1,056 times) (range 222-744 times/station; Table 2).

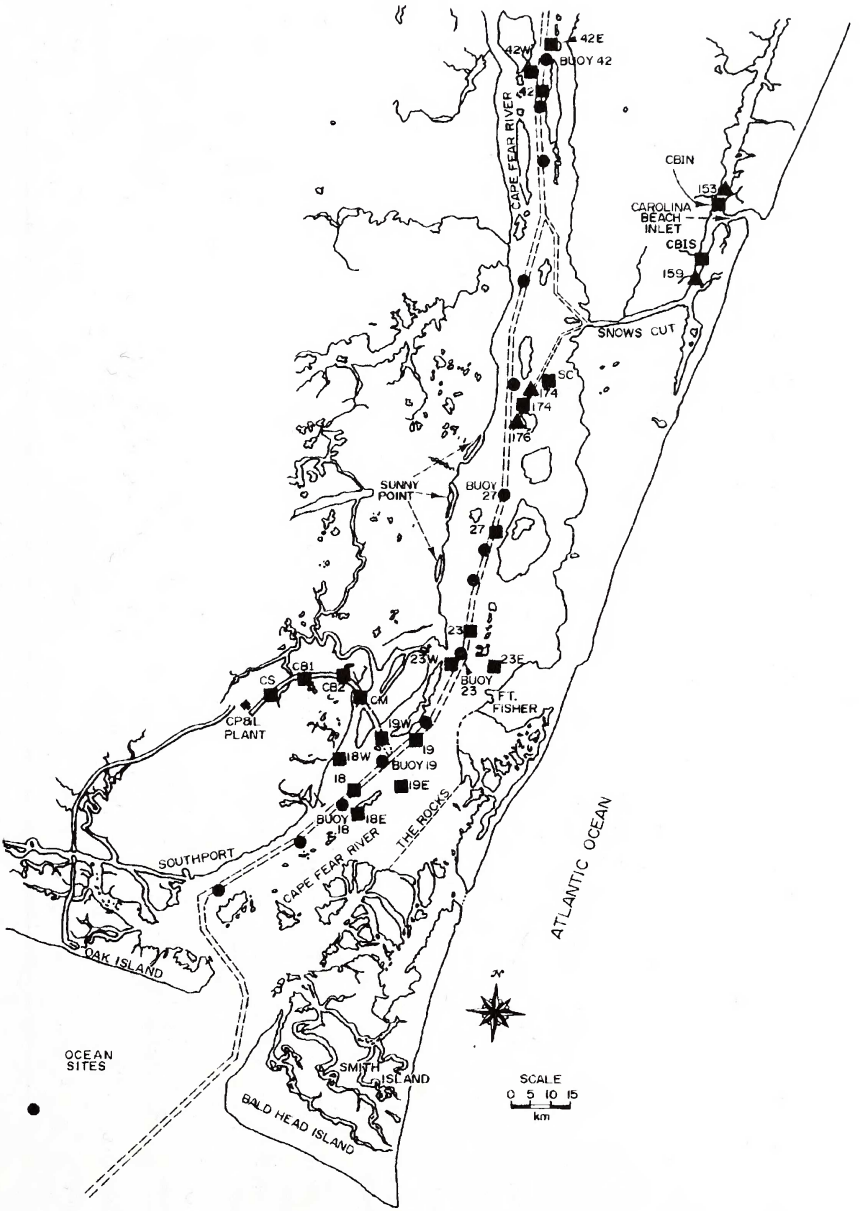

Fig. 1. Locations of river or shoal gill net and otter trawl stations (■), bouys (●), sampled in the Cape Fear River and adjacent areas between 1973 and 1978.

Table 1. Fishes containing siphon tips in their stomach contents and nipping occurrences in Cape Fear River, 1973–1978.

Fishes	Size (mm SL)						Specimens		Nipping					
	Male		Female		Sex Unknown		Examined	With Food	Specimens	Occurrences	Males	Females	Sex Unknown	Percent with siphon tips
	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$	Range								
Bothidae														
Citharichthys spilopterus Bay whiff			97.3	93–100			783	702	3	3	0	3	0	0.4
Etropus crossotus Fringed flounder	83.3	33–97	80.1	49–96	49.5	37–86	2,229	2,043	58	38	26	16	6	4.1
Paralichthys dentatus Summer flounder	80.7	42–110					846	698	3	3	3	0	0	0.4
P. lethostigma Southern flounder	205						746	483	1	1	1	0	0	0.2
Sciaenidae														
Leiostomus xanthurus Spot	86.2	53–168	84.2	48–127	65.2	68–91	6,190	5,179	105	55	65	34	6	2.0
Menticirrus americanus Southern kingfish	84.6	50–135	101.4	60–140	56.4	42–86	1,163	1,096	108	54	58	26	24	9.9
Micropogonias undulatus Atlantic croaker	97.9	58–150	102	65–164	60	28–116	7,169	6,339	349	171	18	120	11	5.5
Achiridae														
Trinectes maculatus Hogchoker	57.8	43–110	56.7	22–104	40.9	38–51	3,185	1,839	138	60	76	54	8	7.5
Soleidae														
Symphurus plaquisa Blackcheek tonguefish			82	80–89			2,580	1,152	2	2	0	2	0	0.2

Table 1. Continued.

Fishes	Size (mm SL)						Specimens		Nipping					
	Male		Female		Sex Unknown		Examined	With Food	Specimens	Occurrences	Males	Females	Sex Unknown	Percent with siphon tips
	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$	Range								
Ephippidae														
Chaetodipterus faber Atlantic spadefish	63.4	54–85	65	54–82	49	29–89	264	243	21	14	5	13	3	8.6
Haemulidae														
Orthopristis chrysoptera Pigfish	99	33–270	74.3	40–128			192	172	9	6	4	5	0	5.2
Serranidae														
Centropristis striata Black sea bass			78				150	113	1	1	0	1	0	0.9
Sparidae														
Lagodon rhomboides Pinfish	88.1	64–112	91.3	74–126	76	66–81	1,698	1,436	90	54	57	29	4	6.0
Triglidae														
Prionotus Leopard searobin	157						266	237	1	1	1	0	0	0.4
Totals							27,461	21,732	453	889	514	313	62	

Table 2. Occurrences, by month, of 14 species containing siphons tips in their stomach contents, Cape Fear River, North Carolina, 1973 through 1978 pooled.

	Month											
Species	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Fringed flounder	0	0	0	1	0	0	0	0	2	0	0	0
Bay whiff	0	0	0	0	1	1	2	1	11	12	0	0
Summer flounder	0	0	0	0	0	0	0	0	2	1	0	0
Southern flounder	0	0	0	0	0	0	0	0	1	0	0	0
Spot	4	3	7	7	12	2	1	2	9	3	5	0
Southern kingfish	1	0	3	1	3	4	2	6	19	11	4	0
Atlantic croaker	5	8	15	26	27	12	7	14	31	17	8	1
Hogchoker	0	1	4	6	9	8	3	6	14	8	1	0
Blackcheek tonguefish	0	0	0	1	0	0	0	0	0	0	1	0
Atlantic spadefish	0	0	0	0	0	0	0	0	11	3	0	0
Pigfish	0	0	0	0	0	0	1	1	2	2	0	0
Black sea bass	0	0	0	0	0	0	0	0	0	0	1	0
Pinfish	2	4	14	7	7	1	1	4	8	0	6	0
Leopard searobin	0	0	0	0	0	0	0	0	1	0	0	0
Total	12	16	43	49	59	28	17	34	111	59	26	1

Table 3. Occurrences of 14 species/station, containing siphons tips in their stomach contents, Cape Fear River, North Carolina, stations listed from north (42E) to south (0), 1973 through 1978 pooled.

	Station																					
	42E	42	42W	CBIN	CBIS	174	SC	27	23E	23	23W	19E	19	19W	SC	CB1	CB2	CM	18E	18	18W	0
Fringed flounder	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Bay whiff	1	0	1	1	2	2	3	0	5	0	6	0	0	3	1	0	1	0	1	0	0	1
Summer flounder	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0
Southern flounder	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spot	3	0	1	2	6	7	5	1	13	3	3	2	2	0	0	1	0	0	1	2	2	1
Southern kingfish	2	0	1	0	1	8	2	1	8	1	0	0	6	2	0	0	1	0	2	1	1	17
Atlantic croaker	3	6	5	3	4	29	13	13	7	13	8	2	16	5	4	2	1	3	9	6	5	14
Hogchoker	2	3	2	0	0	9	2	3	2	5	2	1	15	0	0	0	0	2	2	3	1	6
Blackcheek tonguefish	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Atlantic spadefish	0	0	0	0	0	4	2	1	0	1	1	0	3	0	0	0	0	0	0	0	1	1
Pigfish	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Black sea bass	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pinfish	0	0	0	4	9	7	3	0	4	0	5	4	1	0	0	1	2	0	8	1	1	4
Leopard searobin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total Occurrences	11	10	10	11	27	67	30	19	42	23	25	9	43	11	6	5	5	5	23	13	12	46
Total sampling effort/ station	261	80	263	355	374	323	661	323	701	406	689	707	448	727	222	273	171	260	744	431	666	1056

Stomachs of 84 species of fishes were examined to note percent fullness, percent volume, and frequency of occurrence of each food item. Foods were present in the stomachs of 82 species. Stomach content of each food item was estimated visually by percent volume and determined to the lowest possible taxon.

Environmental features of salinity were noted with A/O refractometers, air and water temperatures with Taylor portable field thermometers, and oxygen content with YSI 51 or 57 units.

RESULTS

Siphon tips were found in the stomachs of 889 individual fishes (4.1% of those examined with food) comprising 14 species and nine fish families (Bothidae, 4 species; Sciaenidae, 3; Achiridae, 1; Soleidae, 1; Ephippidae, 1; Haemulidae, 1; Serranidae, 1; Sparidae, 1; and Triglidae, 1) collected 453 times between 1973-1978 (Table 1). Siphons tips had been eaten by 514 males, 313 females, and 62 specimens whose sex was undetermined (Table 1). Recognizable food was found in 21,732 of the 27,461 specimens (14 species) examined (Table 1).

Croaker (*Micropogonias undulatus*) stomachs (349 specimens) often contained up to 80% of their stomach contents as siphon tips. Hogchokers (*Trinectes maculatus*) (138 specimens) were the second most frequent siphon tip browser, followed by southern kingfish (*Menticirrus americanus*) (108), spot (*Leiostomus xanthurus*) (105), pigfish (*Orthopristes chrysopterus*) (90), and fringed flounder (*Etropus crossotus*) (58) (Table 1).

Regardless of species caught, most specimens containing siphon tips were less than 126 mm, average 90 mm SL (Table 1). Largest specimens eating siphon tips were the pigfish (*Orthopristis chrysoptera*) (270 mm SL), southern flounder (*Paralichthys lethostigma*) (270 mm SL), and leopard searobin (*Prinotus scitulus*) (157 mm SL), respectively (Table 1). Siphon tips were found most often in yearling fishes caught in September (111 times), August, and October (59 each), with least occurrences in December (1) (Table 2).

Sampling effort by station/month ranged between 80-1,056 (Table 3). Fishes with siphon tips in their stomach contents were caught more often at Station 174 (67 times), Buoy 19 (43), 23 (42), and the ocean (46) than at most other stations (Table 3), perhaps as a result of clam patchiness. Most siphon tip nipping occurred in 1976 (155) and 1977 samples (137) (Table 4); the least in 1973. Although sampling efforts were greater in 1976 and 1977 (Table 4), other factors such as cold winter waters or ice cover were perhaps more important in inducing nipping than sampling effort. Low field recorded water temperatures were 7 C in January 1976 and 4 C in January 1977,

Table 4. Siphon tip nipping occurrences by family, species, year, and sampling effort, Cape Fear River, North Carolina.

	Year						
Fishes	1973	1974	1975	1976	1977	1978	
Bothidae							
Fringed flounder	0	0	0	0	1	0	
Bay whiff	0	2	0	6	9	11	
Summer flounder	0	0	0	0	0	3	
Southern flounder	0	0	0	0	1	0	
Sciaenidae							
Spot	1	4	4	18	15	13	
Southern kingfish	0	10	4	17	18	5	
Atlantic croaker	0	26	20	55	43	27	
Achiridae							
Hogchoker	0	4	4	22	23	7	
Soleidae							
Blackcheek tonguefish	0	1	0	0	1	0	
Epippidae							
Atlantic spadefish	0	0	0	1	10	3	
Haemulidae							
Pigfish	0	1	1	2	0	2	
Serranidae							
Black sea bass	0	0	0	0	1	0	
Sparidae							
Pinfish	0	3	1	32	16	2	
Triglidae							
Leopard searobin	0	1	0	0	0	0	
Total occurrences	1	52	34	155	137	74	453
Sampling effort (stations)	1,240	1,417	1,972	2,139	2,116	1,762	10,646

the latter causing ice flow development on the shoals of the river and in the power plant intake canal. As a result, fish kills were common each of the two years at several river stations. Highest water temperatures were 30.5-32.0 C in July 1977. Oxygen levels associated near the ice flows or high water temperatures were always high, yet were critical for some species such as striped mullet, *Mugil cephalus*, grey trout, *Cynoscion regalis*, and menhaden (*Brevoortia tryannus*). Salinities varied by season, station, and after rainfall and runoff, thereby enchancing or preventing greater range utilization of the river system than usual, i.e., channel catfish *Ictalurus punctatus*, a species of the upper river was often found as far down river as Buoy 18 (Fig 1).

DISCUSSION

Although sciaenids (croaker, spot, and southern kingfish) have been reported eating *Donax* or other clam siphons (Modde and Ross 1983, Currin 1984, McMichael 1986, McMichael and Ross 1988, Irlandi 1993, Currin et al. 1994), my study adds 11 species to the list of siphon tip nipping fishes. No attempt was made herein to note the rate of siphon tip regeneration or length of siphon extension (Zwartz et al. 1994). The most severe cold-winter-spring waters ever recorded (1976 and 1977) may have caused increased siphon nipping (Table 4), and surface inhabiting invertebrates to vacate the area or influenced their survival, even death. Clams on the other hand could simply withdraw their siphons during the most severe water temperature extremes and remain in the area. Thus, loss of other winter foods may have made clams the only available food for bottom feeding fishes such as croakers, spot, southern kingfish, etc.

Infrequent literature reports of siphon tips as stomach contents of fishes should be viewed cautiously in light of pre-, during- and post-capture factors. Prevailing environmental events should be factored into the observations rather than simply assuming the presence of a food item was preferred and expected, rather than unexpected (Bonsdorff et al. 1995). Also efforts to interpret the effects of a fish's behavior, such as siphon tip nipping, should consider whether a station was sampled once or repeatedly to determine the long-term effects of fish behavior (aversive or non-aversive; Kvitek 1991) and sampling effects on the local clam population.

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